LARES: An Intelligent Sweet Home for Assisting the Elderly and the Handicapped

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1 Introduction

In the society, each constituent would live his/her life with the blessed feeling of equality. In particular, it would be a society where the aged and elderly and even the disabled would live well independently and comfortably along with the ordinary normal people. Various types of high-tech equipment and systems may provide a good alternative for independent living of such people.

The intelligent house for physically impaired people integrates devices for movement assistance of the resident and devices for continuously monitoring of his/her health status. Such solution will have strong positive emotional impact on the patients, improving their quality of life, giving them privacy and feeling that he/she lives in an ordinary house, not in a hospital. The same approach will reduce significantly the medical care costs per person.

According to various sources, we may confirm that the importance of "smart houses" for the elderly and the disabled has been well understood. In several European countries, a number of demonstration smart houses for testing different strategies of the elderly and the disabled were developed. Here we may mention AID (Assisted Interactive Dwelling) (Bonner, 1988), Smart House (developed at Social Housing SPRU, University of Sussex, UK), HS-ADEPT (Hammond *et al.,* 1996), HERMES, the Smart Home project (at Brandenburg Technical University, Cottbus, Germany), the Gloucester Smart House in UK (oriented to the specific needs of people with dementia), the SmartBo project (Elger *et al.,* 1998), etc.

In contrast to existing automated homes that can be programmed to perform preliminary defined functions, a team of the Colorado University (Mozer*,* 1999) proposes the idea of the smart house where the home controller can essentially

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programs itself by observing the lifestyle and desires of the inhabitants and learning to anticipate their needs.

Fifteen demonstration and research houses, known as Welfare Techno Houses, have been recently built across Japan. A life-support infrastructure environment, called "Robotic Room" was developed at the Sato Laboratory at the Research Center for Advanced Science and Technology in the University of Tokyo (Sato *et al.,* 1996, 1999) in response to the needs of the rapidly ageing society.

Present paper comments some of the conceptions that were implemented in our sweet-home project LARES. Proposed organisation of the smart house considers some recent technology innovations as well as some specifics in the lifestyle and traditions in Korea.

2 Intelligent Sweet Home

2.1 Overall System

R&D of intelligent human-friendly residential system is urgently in demand to comply with the needs of human being to lead more convenient and safe lives and to deal with the increase in the number of the elderly and the handicapped. To this end, our work is focused on the development of three detailed research parts: 1) intelligent bed robot, 2) soft remocon, 3) network as shown in Figure 1.

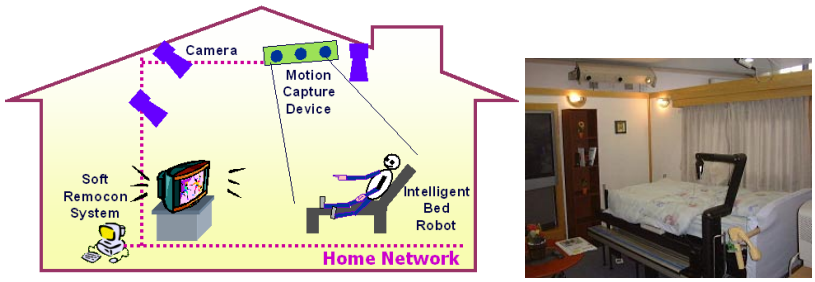

Figure 1. Overall system of intelligent sweet home

2.2 Intelligent Bed Robot

An intelligent bed system is developed to assist the elderly and the handicapped to live a convenient daily life since they usually spend much time in their beds. Figure 1 shows the prototype of the bed system consisting of three parts – automatic bed, robotic arm and motion capture system.

The bed is designed in consideration of human body and can change its pose in various ways. The upper part can be folded from 0 to 90 degrees and the folded curve is similarly formed as the curve from pelvis to waist of human body by adopting 4-bar mechanism. The lower part is folded from –70 to 70 degrees for the user to keep a comfortable pose. MANUS arm is attached to the side of the bed and

is utilized to serve transporting objects, pulling a quilt over, etc. To inform the robotic arm of the on-line position information of objects with high accuracy in real time, the motion capture system is utilized and the active ultrared sensors are attached to the objects.

The intelligent bed robot with a proposed configuration is very useful to assist daily life of the elderly and the handicapped, and is able to serve four kinds of fundamental tasks: pulling a book and put it back on the bookshelf, transporting a newspaper, giving a message, and pulling a quilt over and putting away it.

2.3 Soft Remocon

The remote controller seems to be a good choice for normal people, but it cannot be helpful for the handicapped/elderly since it happens that they cannot move themselves to find the controller nor remember where it is. Recognising an object pointed by a finger and a successive hand gesture for commanding machines is an alternative way in the sense of human-friendliness since it is how human does.

We have attached 3 cameras on the ceiling to capture the arm position. Though two cameras are enough to calculate the direction of the arm, one more camera is installed for the case when the arm occludes in the view of another camera. We have implemented algorithms for extracting arm image, calculating the arm direction, and finding the nearest object as well as general infrared signal transmission system for specified home appliances. To extract the arm image from the colour image from each camera, we adopt the normalised RGB transformation to find the skin colour, and remove face area by relative positions of the face and the arm. To calculate arm direction, we use the images of two cameras out of three which can detect the whole arm. From one image, we only can know a plane which contains the direction vector of the arm. Thus we can find the direction vector by finding the line of intersection of two planes from two images. To find the nearest object among the specified objects, we compare the difference vector between the arm direction vector and an object vector to find the object which have the minimal difference vector. Finally, by investigating 32 bit control codes of various home appliances, we have implemented the general infrared signal transmission system. Currently, we are able to do on/off control for those several home appliances including TV, VCR, automatic door, light and curtain. Figure 2 shows the procedure of finding the arm area and the arm direction.

Figure 2. Pointing recognition

2.4 Network

The intelligent sweet home consists of many assistive devices and sensors such as robotic arm, motion capture device, camera system and hand gesture recognition system. Since some devices are responded to the other devices, network connection is in demand to comply with sharing information each other and TCP/IP-based network configuration is established with home network server.

3 Concluding Remarks

In this preliminary result of developing an intelligent sweet home, we have suggested and have implemented several components which help them have independent daily living. Further, according to evaluation by the handicapped, we have collected feedbacks which will be seriously considered for designing the next version of the systems. We believe that one of the biggest reforms to occur in residential space is to adopt various service robots to help habitants in many ways.

The idea of intelligent sweet home is treated at present not as a science fiction but as important goal with strong social and economics aspect. Its realisation will give a solution of many existing problems of the welfare society and will make the handicapped/elderly's lives as well as human life much pleasant and easier.

4 Acknowledgements

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5 References

Bonner S (1998) SMART technology demonstrator site. In: Proceedings of the 3rd TIDE Congress, Helsinki, Finland

Eguchi I, Sato T, Mori T (1996) Visual behavior understanding as a core function of computerized description of medical care. In: Proceedings of the 1996 IEEE/RSJ International Conference on Intelligent Robots and Systems, pp 1573-1578

Elger G, Furugren B (1998) SmartBO - An ICT and computer-based demonstration home for disabled. In: Proceedings of the 3rd TIDE Congress, Helsinki, Finland

Hammond J, Sharkey P, Foster G (1996) Integrating augmented reality with home systems. In: Proceedings of 1st international conference on disability, virtual reality and associated technologies ICDVRAT '96, pp 57– 66

Mozer MC (1999) An intelligent environment must be adaptive. IEEE Intelligent Systems and their Applications 14(2):11-13

Nakata T, Sato T, Mizoguchi H, Mori T (1999) Synthesis of robot-to-human expressive behavior for human-robot symbiosis. In: Proceedings of the 1996 IEEE/RSJ International Conference on Intelligent Robots and Systems, pp 1608-1613